Air quality forecasts using the NASA GEOS model

Christoph A. Keller

NASA Global Modeling and Assimilation Office (GMAO)
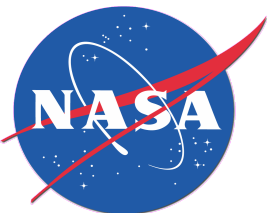Universities Space Research Association (USRA)

In collaboration with:

GMAO: K. Emma Knowland, Eric J. Nielsen, Clara Orbe, Lesley Ott, Steven Pawson, Emily Saunders

Atmospheric Chemistry and Dynamics Lab: Bryan Duncan, Melanie Follette-Cook, Junhua Liu, Julie Nicely
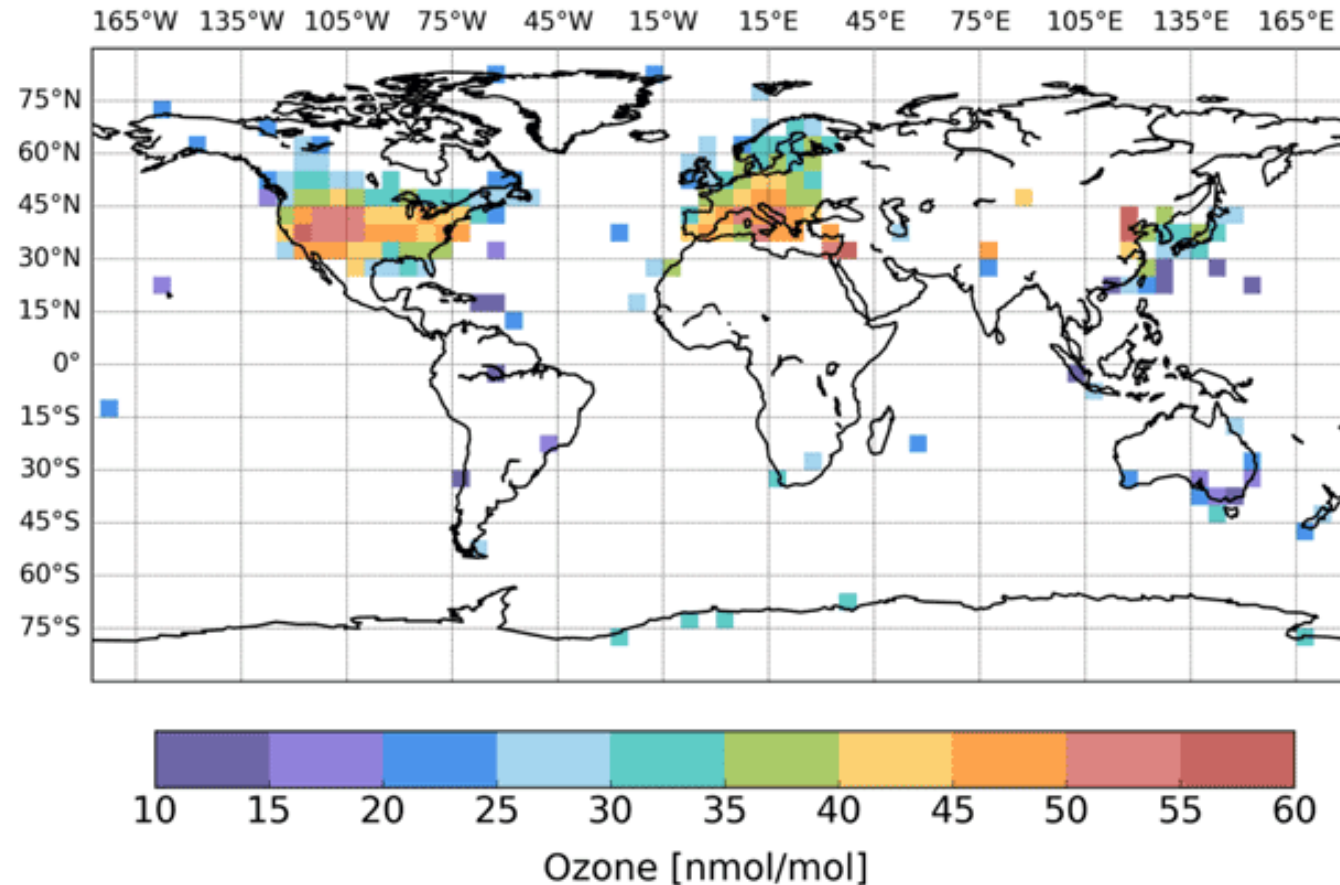
AMS 98th Annual Meeting
10 January 2018

Air quality is a global problem

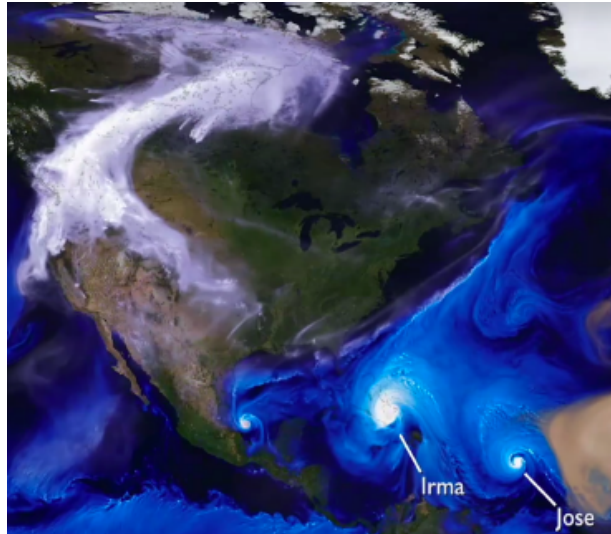
➢ 1 of every 9 death is related to air pollution (WHO)

➢ $5 Trillion in welfare losses every year (World Bank)

➢ Locally up to 50% crop loss due to ozone
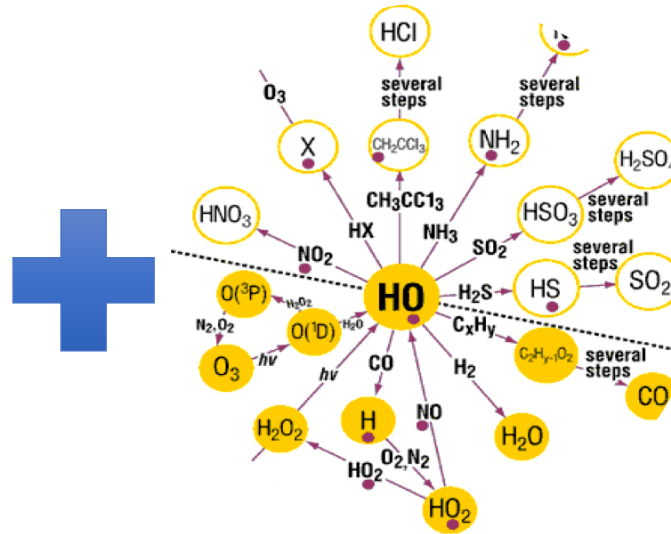
Need global models to fill gaps in observations

Tropospheric Ozone Assessment Report TOAR (Schulz et al., 2017)

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GEOS composition forecasting system (GEOS-CF)

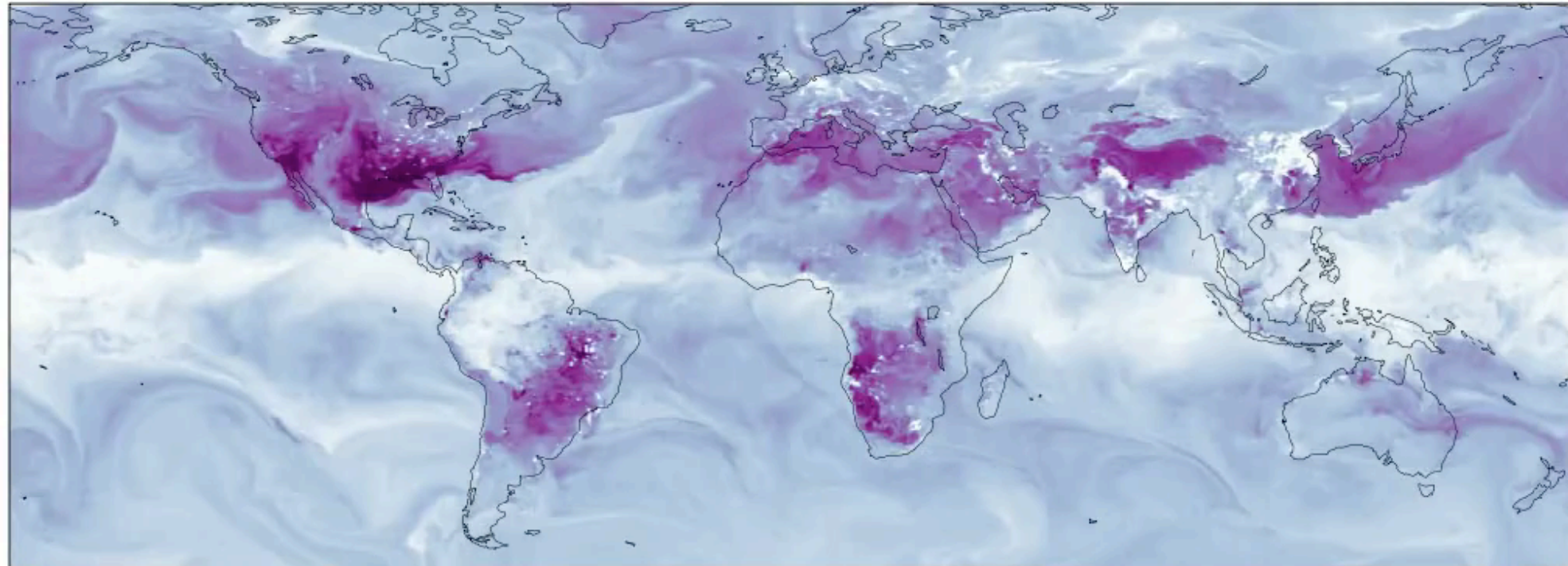**GEOS - FP**

GEOS - Chem

GEOS - CF

➢ 1-day analysis

➢ 5-day forecast

➢ 0.25° resolution

➢ Aerosols

➢ Reactive gases

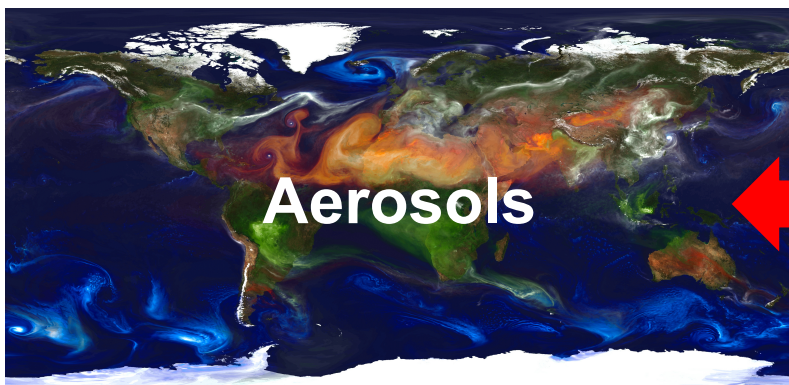Running since March 2017 – still in test / evaluation mode

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GEOS-CF surface ozone

2017-10-01 00:30 UTC

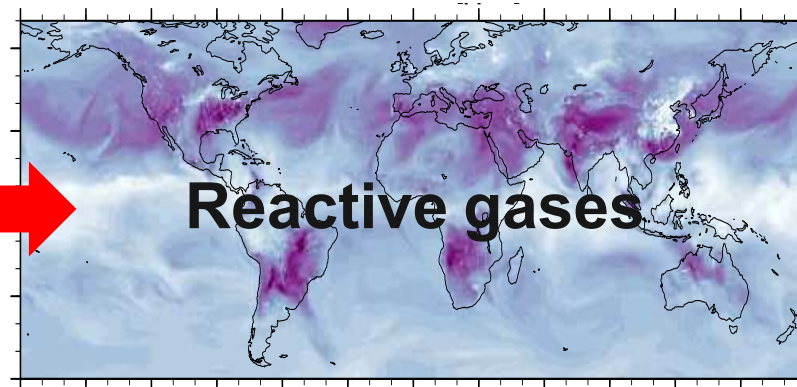Surface ozone [ppbv]

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Contributors to air pollution

Aerosols

➤ Particulate matter:

- Organic Carbon
- Black Carbon
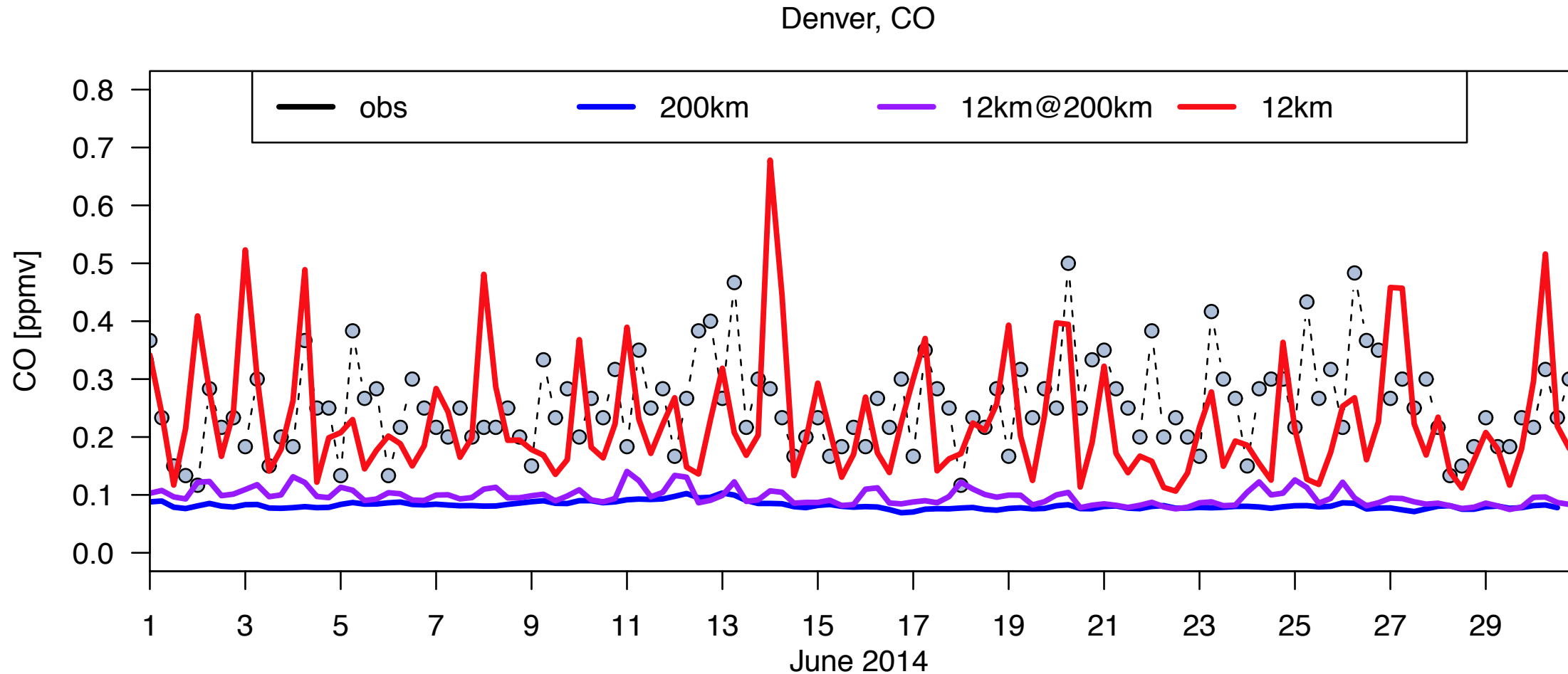- Sea salt
- Nitrate
- Sulfate
- Dust

GOCART

Reactive gases
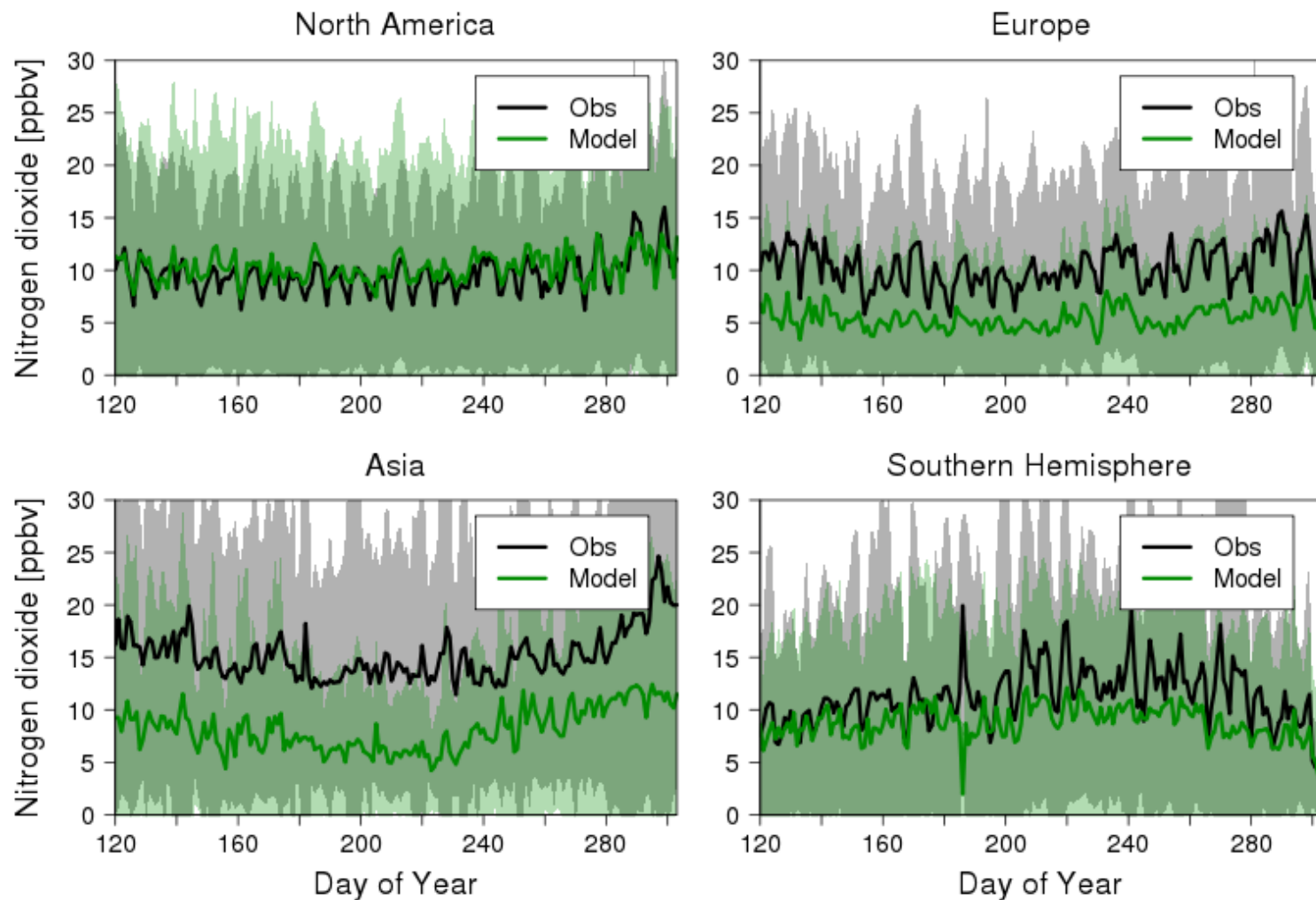
➤ Ozone

➤ Nitrogen dioxide

➤ Carbon monoxide

➤ Volatile organic compounds:

- Formaldehyde
- Benzene / Toluene
- And many more!

GEOS-Chem

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High resolution critical to resolve features relevant to air quality

Denver, CO

Global evaluation of NO$_2$: comparison against surface observations

https://openaq.org

Local evaluation of NO_2: good temporal correlation with surface observations (where available)
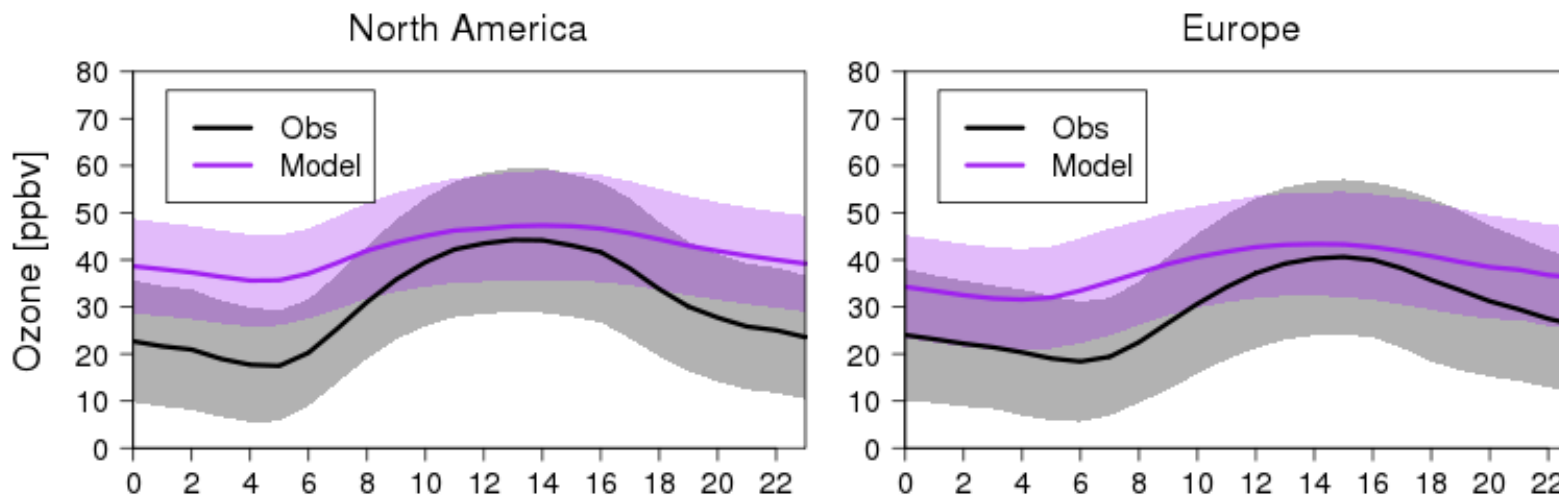

Zurich, Switzerland, 2017-10-14 00:00 UTC
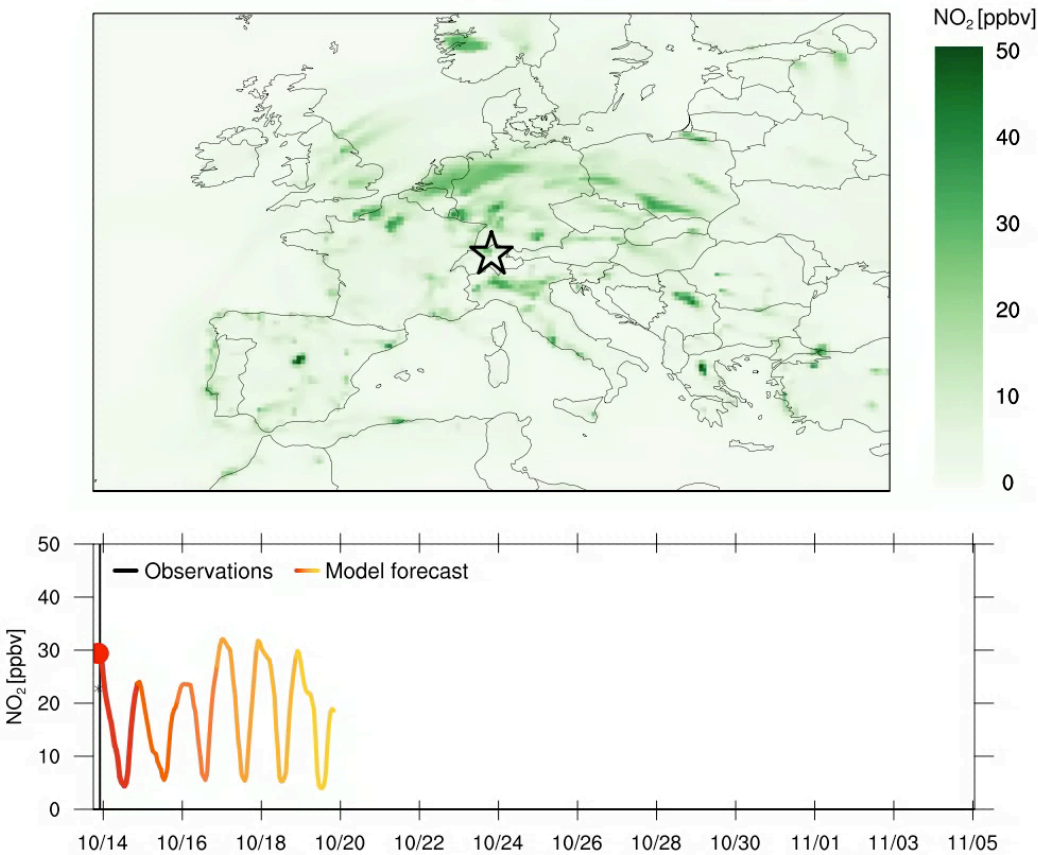
High bias in surface ozone, but diurnal cycle is well captured
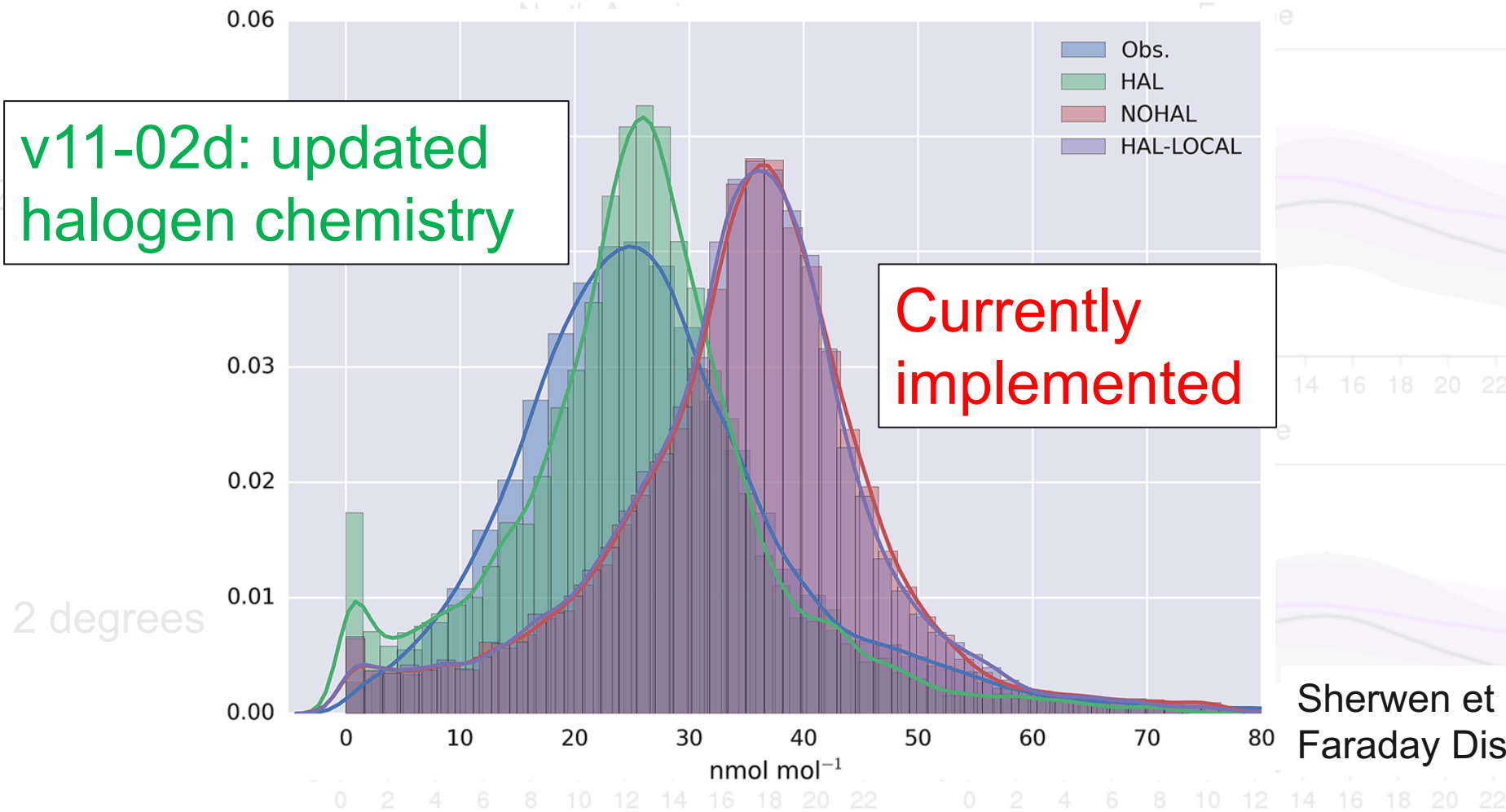

0.25 degrees

2 degrees

Published on 06 February 201
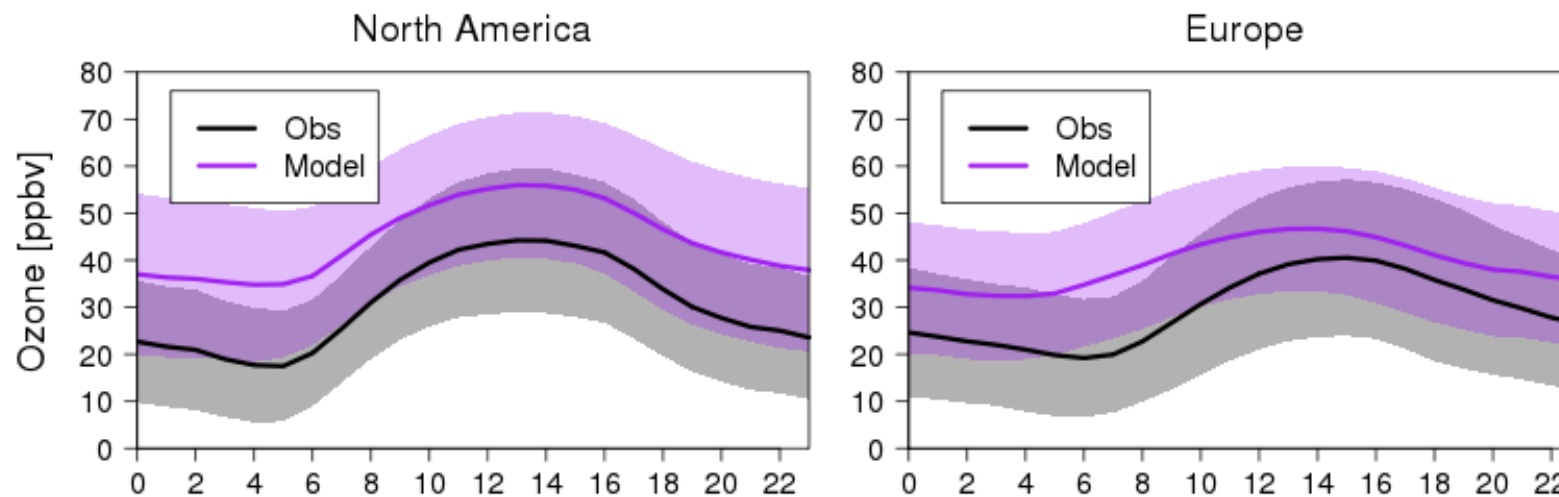
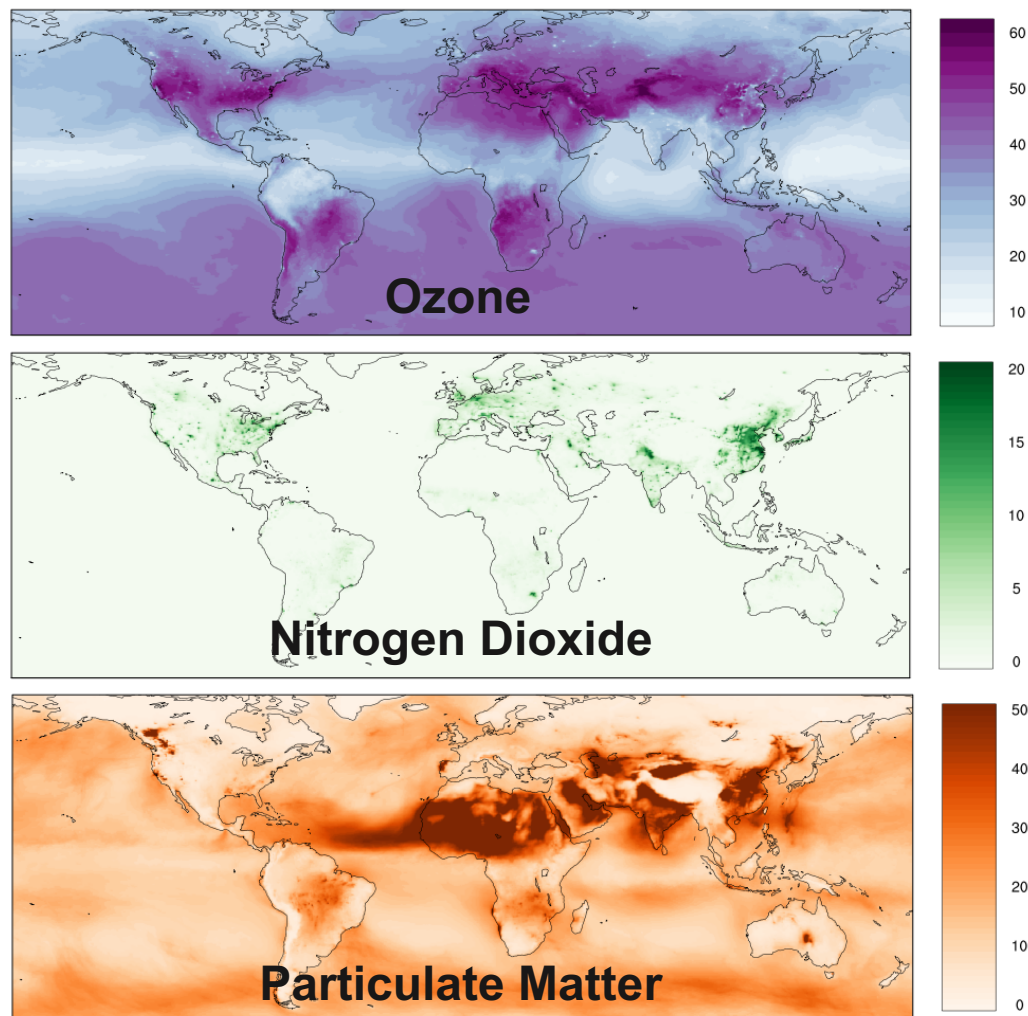# Will new chemistry mechanism reduce ozone bias?

v11-02d: updated halogen chemistry
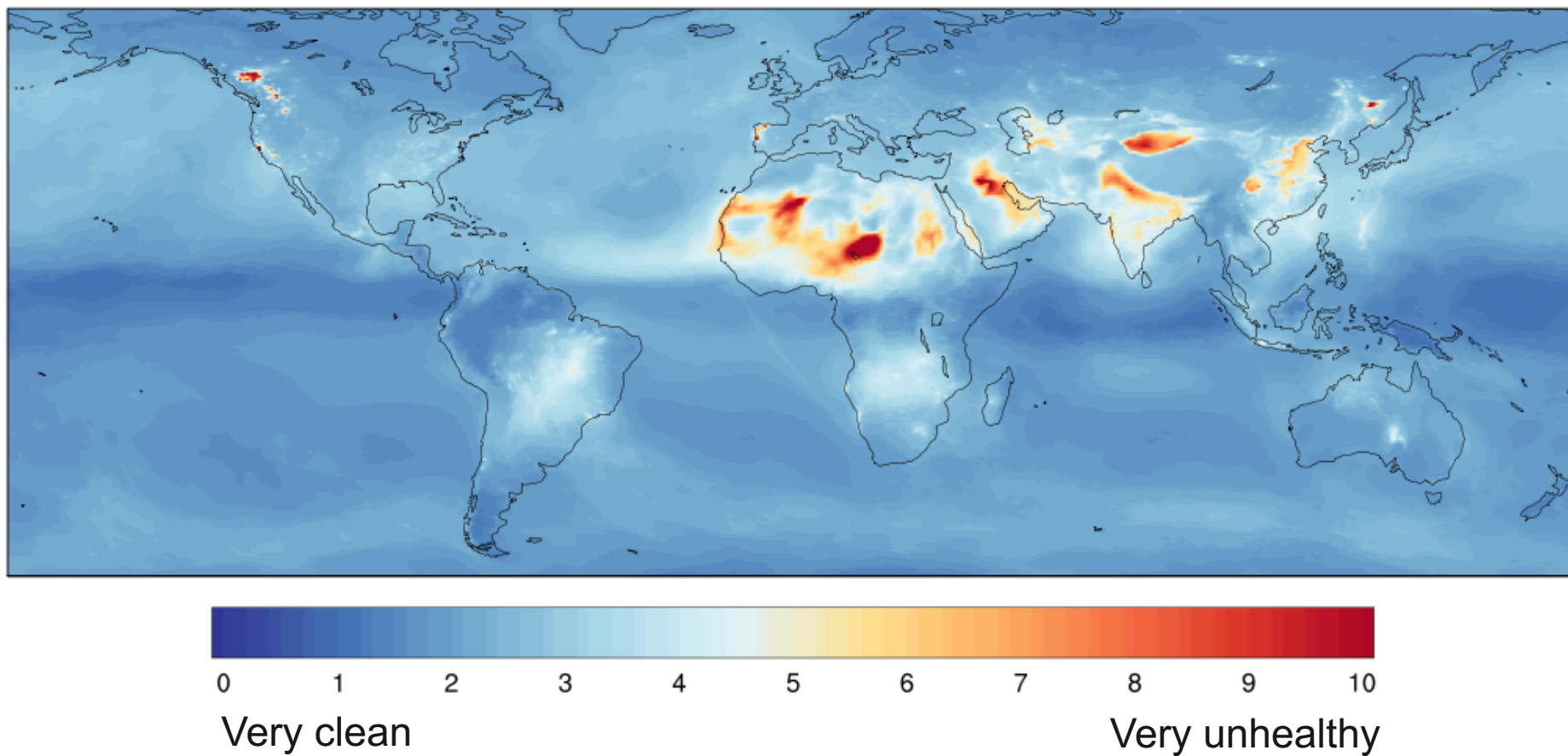
Currently implemented

Sherwen et al., 2017, Faraday Discuss.

Application: Health Air Quality Index (HAQI)

➢ HAQI is a function of O_3, NO_2, and $PM_{2.5}$ (e.g. Stieb et al., 2008)

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Application: Health Air Quality Index (cont.)

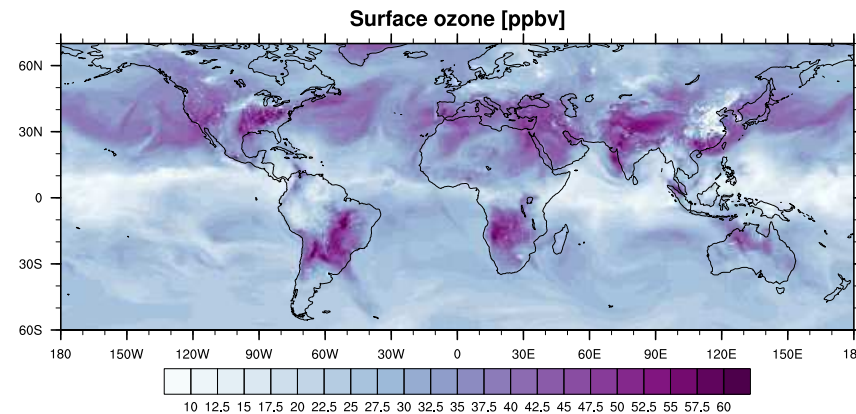

Very clean   Very unhealthy

➤ NYU and UNICEF will use GEOS-CF to refine HAQI for children

Summary

- GEOS-CF produces daily global air quality forecasts at 25km horizontal resolution

- Output available to public in early 2018

Under development:

- 2-5 year simulation to collect statistics

- Assimilation system for trace gases (O_3, NO_2, CO)

Surface ozone [ppbv]

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